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Towards conceptualizing reverse service supply chains[1]

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Structured Abstract:

Purpose – Recognizing the heterogeneity of services, this paper attempts to clarify the characteristics of forward and the corresponding reverse supply chains of different services.

Design/methodology/approach – The paper develops a two-dimensional typology matrix, representing four main clusters of services according to the degree of input standardization and the degree of output tangibility. Based on this matrix, we develop a typology and parsimonious conceptual models illustrating the characteristics of forward and the corresponding reverse supply chains of each cluster of services.

Findings – The four main clusters of service supply chains have different characteristics. This provides the basis for the identification, presentation and explanation of the different characteristics of their corresponding reverse service supply chains.

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Research limitations/implications – The findings of this research can help future researchers to analyse, map and model forward and reverse service supply chains, and to identify potential research gaps in the area.

Practical implications – The findings of the research can help managers of service firms to gain better visibility of their forward and reverse supply chains, and refine their business models to help extend their reverse/closed–loop activities. Furthermore, the findings can help managers to better optimize their service operations to reduce service gaps and potentially secure new value-adding opportunities.

Originality/value – This paper is the first, to our knowledge, to conceptualize the basic structure of the forward and reverse service supply chains while dealing with the high level of heterogeneity of services.

Keywords:

Service, Service supply chain, Forward supply chain, Reverse supply chain, SCM

1. Introduction

Reverse supply chains are an important current focus of research (Mondragon *et al.*, 2011; Govindan *et al.*, 2015). The concept is predicated on the maximization of value creation, securing sustainable development opportunities throughout products' lifecycles, and dynamic value creation from different types of returns over time (Govindan *et al.*, 2015). To date, the manufacturing sector has provided the context for the majority of reverse supply chain (RSC) research (e.g. Jayaraman *et al.*, 1999; Blackburn *et al.*, 2004; Jayaraman and Luo, 2007; Huang *et al.*, 2013; Mafakheri and Nasiri, 2013; Chuang *et al.*, 2014). Although the supply chain concept is increasingly being used in sectors outside of manufacturing services (e.g. Sampson, 2000; Ellram *et al.*, 2004; Giannakis, 2011; Lillrank *et al.*, 2011; Vries and Huijsman, 2011; Shi and Liao, 2013), the interest in the reverse service supply chain (RSSC) is more recent and nascent in nature (Amini *et al.*, 2005; Bienstock *et al.*, 2011).

How significant is the RSSC and, conceptually, what are the key design issues? The answers to these two questions matter because of the service sector's share of gross domestic product (GDP) and its heterogeneity. The service sector is the largest contributor to the GDPs of the developed economies. For example, in the United States the service sector accounts for 68% of GDP and four out of five jobs (OUSTR, 2014) and in the UK it accounts for around 78% of GDP (ONS, 2014). The significance of the service sector is growing rapidly within the emerging and developing economies. The service sector is both broad and inherently heterogeneous – points discussed more fully in the next section. This heterogeneity affects both the importance and the design of forward service supply chains (FSSCs) and reverse service supply chains (RSSCs); hence no single FSSC or RSSC model is capable of depicting the service sector as a whole.

Service supply chains possess different characteristics to manufacturing supply chains (Sampson, 2000), hence RSSCs need to be conceptualized differently in order to capture the unique characteristics of a diverse groups of services. The research examining the RSSC is showing potential, but is sparse, thus limiting our understanding (Sampson, 2000; Bienstock *et al.*, 2011). The growing significance of services calls for greater research effort, developing conceptual understanding, guiding empirical research and facilitating more effective RSSC operations in practice.

The aim of this paper is to develop a conceptual model/typology of FSSCs and RSSCs. We first develop a two-dimensional service firm typology based on output tangibility/intangibility and input customized/standardized continuums as they impact on the design of FSSCs and RSSCs. The proposed service supply chain (SSC) typology potentially aids future theoretical/empirical research, as well as practising managers, by highlighting the significance of operations and the design characteristics enabling them to better address potential RSSC issues.

A review of the extant literature is presented in Section 2, and FSSCs and RSSCs are defined. In Section 3 we discuss methodology; in Section 4 we introduce our two-dimensional matrix, which serves as the foundation for our conceptual model and typologies introduced in Section 5. In Section 6 we discuss the implications, and we draw conclusions in Section 7.

2. Literature review

The current focus of RSC research is primarily on *manufacturers'* reverse flow (e.g. Jayaraman *et al.*, 1999; Blackburn *et al.*, 2004; Jayaraman and Luo, 2007; Huang *et al.*, 2013; Mafakheri and Nasiri, 2013; Chuang *et al.*, 2014). The few existing studies examining the RSSC rely on manufacturing concepts or service activities that are treated as supporting functions of the manufacturing supply chain (Amini *et al.*, 2005; Bienstock *et al.*, 2011).

2.1 Heterogeneity of service supply chains

The diversity and context dependency of SSCs contributes to the paucity of conceptual RSSC studies (Sampson, 2000; Ellram *et al.*, 2004; Giannakis, 2011). Compared with manufacturing supply chains, SSCs are heterogeneous in nature for five reasons.

First, services encompass almost all economic activities apart from agriculture, mining and manufacturing (Goodman and Steadman, 2002; Ellram *et al.*, 2004). Heterogeneity not only occurs between sectors, but also exists within sectors affecting the design and operation of both FSSCs and RSSCs (Veronneau and Roy, 2009).

Second, service value chains display significant variations between and across sectors. According to Porter (1985), value is what buyers are willing to pay and the value chain consists of a set of primary and support activities that an organization carries out to create value for its customers. In some sectors, service elements dominate the value chain as primary activities creating the majority of value for the customer, for example, consultancy services, education and finance. However, in other sectors service contribution to value creation is more balanced vis-à-vis other elements of the value chain. For example, in retail, in-bound logistics and the effectiveness of operations also make significant contributions to the creation of value.

Third, the value chain processes of service firms are much less standardized compared to those of typical manufacturing firms. Service firms' outputs display significant variations and uncertainties due to the sizeable human involvement (Sengupta *et al.*, 2006). Furthermore, the requirements and expectations of customers can be very different from case to case (Schmenner, 1986; Sampson, 2000).

Fourth, service provision largely tends to be decentralized (with some notable exceptions), because decisions are generally taken locally to meet the varied customer requirements (Sampson, 2000; Sengupta *et al.*, 2006). Moreover, when services are outsourced, the procurement of services is often not centrally managed but based on local requirements (Ellram *et al.*, 2004). Hence outputs are also likely to vary from case to case.

Fifth, uncertainties in processes due to significant human involvement and the variations in service outputs due to varied customer requirements tend to make service evaluation and performance measurement highly complex and differentiated (Ellram *et al.*, 2004). In turn, this compounds the complexities of SSC standardization and conceptualization.

2.2 Products as bundles of goods and services

Sampson (2000) argued that services are not solely intangible and their provision is often dependent on facilitating goods. According to Davis and Heineke (2003) service products can be viewed as bundles of goods and services across a continuum, with groceries at one end, having close to 100% facilitating goods, and consultancy at the other end, with close to 100% intangible provision, and other services in between.

Services, depending on their position on the continuum, will possess different operational characteristics (Davis and Heineke, 2003; Ellram *et al.*, 2004). Hence, a one-model-fits-all approach will not suffice.

Previous research focused on services offering intangible product (output) bundles capturing the position at one end of the continuum (e.g. Sampson, 2000; Ellram *et al.*, 2004; Giannakis, 2011). These do not necessarily reflect the realities of the forward and reverse supply chains of services occupying other positions on the continuum. In this paper we attempt to differentiate between the FSSC and the RSSC, utilising critical distinguishing dimensions. We maintain that a clear typology will allow for a more fine-grained representation of the FSSC and the RSSC.

2.3 Towards definitions of forward and reverse service supply chains

The traditional definition of supply chain management (SCM) does not readily apply to services. Hence Ellram *et al.* (2004, p. 17) defined SCM for services as: "the management of information, processes, capacity, service performance and funds from the earliest supplier to the ultimate customer". The focus here was on service operations outsourcing – limiting its scope.

Johnson and Mena (2008, p. 28) provided a similar definition, but with a focus on servitization strategy. They defined SCM of servitized products as "the management of information, processes, capacity (people, equipment and facilities), products, services and funds from the earliest supplier to the ultimate customer".

As Albino *et al.* (2002, p.119) suggested, "a supply chain can be analyzed as a network of production processes. Each process can be defined as a system that produces output flows in consequence of input flows". From this perspective, a service firm is a value-adding unit transforming inputs into service outputs. As such, SSCs entail the flow of non-physical inputs and outputs, or bundles of physical and non-physical inputs and outputs. The flow of information, funds, and intangible and tangible inputs and outputs is common to all services. The differences arise from the tangibility and/or intangibility of inflows and outflows, which vary significantly from one service firm to another, regardless of whether they fall within the same or a different standard industrial classification (SIC) code.

In this paper, we rely on a single broad definition of service SCM based on previous studies: “the management of the flow of information, funds and materials between the service firm, its earliest suppliers and the ultimate customer in the process of transforming tangible and/or intangible inputs into tangible and/or intangible service outputs valued by the customer”. We do not specify the direction of flows as flows are bi-directional – not least because of the “customer–supplier duality” highlighted by Sampson (2000).

In manufacturing, the direction of flow determines whether the supply chain is forward or reverse. For example, the American Reverse Logistics Executive Council defined the RSC as “the process of planning, implementing, and controlling the efficient, cost effective flow of raw materials, in-process inventory, finished goods and related information from the point of consumption to the point of origin for the purpose of recapturing value or proper disposal” (Govindan *et al.* 2013, p. 320). However, as Blackburn *et al.* (2004) noted, not all reverse manufacturing supply chains possess similar characteristics; the dissimilarities are accentuated in the case of service organizations because of the heterogeneity discussed previously. For SSCs it is more difficult to identify the RSSC simply by the direction of flow of information or inputs, because it is very likely that an SSC will have bi-directional flows of information/inputs and will have multiple input points (Sampson, 2000). Hence, a different approach for defining the RSSC is needed.

Another approach for identifying the RSSC is to consider triggers, simply because the reverse flow is logically instigated by an event, for example, when customers become dissatisfied with the service or want to cancel the service contract, or when they want to return the tangible part of a service output that may have become faulty or reached the end of its useful life. Consequently, it is reasonable to identify the RSSC through such triggers. Therefore in this study we define RSSC management as “the process of planning, implementing and controlling the efficient and cost effective flow of tangible and/or intangible input and output between the point(s) of consumption and the point(s) of origin, induced by a service cessation event, for the purpose of recapturing value or proper disposal”. This definition, again, does not restrict the direction of flow of input/output to the RSSC; instead it recognizes all possible flows of intangible and tangible inputs and outputs.

3. Methodology

We take our lead from Meredith (1993), arguing that conceptual model building creates a balance between inductive and deductive reasoning enabling academics to lead and guide managerial practices. We broadly follow the methodology suggested by Meredith (1993) and deployed by other SCM scholars (e.g. Carter and Rogers, 2008).

Figure 1 illustrates the process we followed. First, we reviewed the relevant literature identified through a rigorous search of two major databases – ABI/Inform and EBSCO – using keywords such as: service/supply chain, service/supply chain management, service/reverse supply chain, service/closed/closed-loop supply chain, and in each case we conducted the search with the word "service" included and with it excluded. Each search was preceded by terms such as definition, theory, concept, model, typology and inductive/deductive research. An extensive database of relevant literature was developed through initial searches.

We then examined this literature in detail and, based on our initial reading, conducted further searches adding additional literature to our database. This phase, in particular, involved consulting books referred to by papers in our database. Our conceptual development is the product of the integration of different works, summarizing common elements through extensive discussions, contrasting the key concepts, synthesizing the outcomes of our findings and applying "logical deduction" along the lines suggested by Wacker (1998) and Handfield and Melnyk (1998).

[Insert Figure 1 about here]

We used the previous literature (see Table 1) to identify key dimensions of service typology and narrowed these down to dimensions helpful in the classification of reverse supply chains. These dimensions (standardization of process and input, and tangibility of expected service output) were used as the basis for the development of a two-dimensional matrix (see Figure 2 in Section 4). We then used this typology, our summary of the literature, extensive discussion and logical deduction to develop four archetypal service clusters (see Figure 2).

[Insert Table 1 about here]

We drew on the knowledge of four field experts in our effort to identify the four archetypal service clusters. Our selection criteria for experts were: (1) alignment between knowledge and research field; (2) publications in leading journals; and (3) research leadership. Panels of experts offer opinion diversity, independence, knowledge decentralization and opinion aggregation (Surowiecki, 2004). We used a variant of the Delphi technique based on populated charts to obtain experts' opinions on the archetypal service clusters (VandeVen and Delbecq, 1974), but experts were also asked to independently name some typical services or service firms and note these on separate cards. They were then asked, independently, to place their cards onto the two-dimensional matrix that had been developed. A researcher then compared the four independently populated charts, noting the area of the chart on which the cards were placed as well as the similarities and differences. Thirty different services were identified by the experts, while 18 of those services were shared between experts, within these 18 shared services 12 were put into the same quadrant by all four experts yielding an inter-rater reliability of 66.7% (Gwet, 2014). Where there were differences the experts were consulted to ascertain the logic of their choices. The aim was to gain consensus, but where this was not forthcoming a simple majority rule was applied. In the event there were only a few such cases and experts reached consensus during the interview stage described below. The process enabled the development of a single consolidated chart, with services having similar characteristics being grouped together in an appropriate quadrant.

To enhance reliability, one of the researchers conducted a short open-ended interview with each of the four experts independently, asking them to comment on why they had placed the service in a particular quadrant and whether the overall typology was robust. Services placed in a particular quadrant based on the majority rule (mentioned above) were highlighted and consensus was reached at this stage. The literature was revisited, using the service typology we had developed, in order to specify and illustrate the basic structure and activities of the FSSC and the corresponding RSSC of firms belonging to each archetypal service organization. The unit of analysis was service firm. As a result of this process four FSSC and RSSC models were developed for each archetypal service firm cluster. This culminated in a typology of FSSCs and RSSCs (see Figure 3 in Section 5).

With the set of preliminary conceptual models developed, we followed a similar approach to Lyles (1990) and Carrol (1994) by developing an open-ended questionnaire and conducting a survey of academic experts world-wide to verify the veracity and relevance of the proposed parsimonious conceptual models. We identified a panel of 52 academic experts who had published in the previous five years in leading journals, focusing on green or reverse logistics and supply chain, service characteristics, service operation, service classification, service logistics, service procurement including public organizations, and service supply chain.

We developed the open-ended questionnaire using Qualtrics – a popular internet-based survey engine – allowing a combination of diagrams and text within the survey instrument. The questionnaire was designed to ascertain the experts' views on the two-dimensional service typology and the four parsimonious models, as well as the definitions of key terms, such as FSSC and RSSC, service input and output, and the examples of archetypal services. Respondents were asked: (1) To what extent does the service typology accurately capture the different types of services? (2) Are there any service types not covered by this typology? and (3) To what extent does each of the four conceptual models represent the essential characteristics of the FSSCs and RSSCs of different type of services? The survey was included as a hyperlink in the invitation email sent to our panel of academic experts. We received 39 responses, but only 21 were fully completed resulting in an effective response rate of 40.38%. This compares favourably with responses received by previous researchers targeting a similar population (Lyles, 1990). Table 2 summarizes the basic profiles of the respondents.

[Insert Table 2 about here]

Two of the authors independently reviewed the responses and noted the emerging themes before comparing and synthesizing the responses; they had a consistent interpretation to most of the open-ended responses and reached consistency on the small number of responses with discrepancies after open discussion. While most of the respondents generally agreed with the efficacy of the typology and the parsimonious conceptual models, discrepancies in opinions were reviewed by undertaking further review of the literature to improve and refine the preliminary conceptual models in order to reach the final parsimonious conceptual models.

4. Towards a service typology

The heterogeneity of services makes it difficult to develop a grand conceptual model/theory of service firms (Verma and Boyer, 2000). To advance our nascent understanding of service firms' forward and reverse supply chains we need to develop clusters of service firms with common characteristics relevant to the conceptualization of their forward and reverse supply chains. Therefore construction of a robust service typology is a critical first step in the advancement of a conceptual RSSC. To this end, we carefully examined the typologies proposed by leading scholars in the field (including those of Judd, 1964; Rathmell, 1974; Shostack, 1977; Sasser *et al.,* 1978; Hill, 1977; Kotler, 1980; Chase, 1981; Lovelock, 1983; Schmenner, 1986, 1995; Mersha, 1990; Chase and Hays, 1991; Kellog and Nie, 1995; see also Table 1) in light of the definition of RSSC.

A product seems a logical dimension of a service typology designed to dovetail with the development of conceptual models of the reverse supply chain. It was central to the typologies developed by a number of scholars (Shostack 1977, 1982; Sasser *et al.,* 1978; Goodman and Steadman, 2002; Davis and Heineke, 2003). We used the idea of the proportion of goods and services making up a product, suggested by Davis and Heineke (2003), to delineate one dimension of our typology because it can be objectively assessed. Moreover, it fits with the current definitions of a reverse supply chain and is the foundation of a number of prominent existing typologies.

In assessing the proportion of tangible goods and services making up a product, it is not sufficient to solely consider the product bundle. Rather, it is crucial to consider how the product bundle is viewed by customers. For example, the core bundle offered by mobile telecoms companies comprises mobile voice and data services. To reach the market all the telecoms companies have retail businesses, and the design and function of handsets is also highly valued by customers.

Another common element in definitions of the reverse supply chain is "value generation", which in turn is process driven (Silvestro *et al.*, 1992; Hill *et al.*, 2002). To this end, a number of scholars have argued that manufacturing process labels (namely "one-off" or "project", "batch" or "continuous" process) can also be applied to service firms' processes (Sasser *et al.*, 1982). Others have argued that such

classifications do not fully take into account the inherent variability created by customer requirements (Silvestro *et al.*, 1992). To address this criticism, some researchers have developed process typologies using the extent of service customization, so that at one extreme service processes are highly customized to meet the needs of each customer, and at the other extreme standardized processes are deployed to produce the desired product bundle (Maister and Lovelock, 1982; Kellog and Nie, 1995). We extend this classification and suggest that services can be produced through either customized/non-standardized processes and inputs, or standardized processes and inputs.

By linking the two elements found commonly in the definitions of reverse supply chain with the previous service sector typologies, we developed a two-dimensional matrix reflecting the characteristics of key clusters of services pertinent to such supply chains (see Figure 2). Later we use this matrix to develop the structure of forward and reverse supply chains of service organizations falling within each of the four service clusters identified.

As shown in Figure 2, the horizontal axis represents the degree of tangibility of the service output; the vertical axis represents the degree of standardization of the process and input. Four clusters of services are therefore indicated by this matrix.

[Insert Figure 2 about here]

For the Type I cluster, service output (product bundle) is typically intangible as valued by customers, but the process of producing the output relies on customized input. Examples include medical service, business consultancy, barbershop and repair service.

For the Type II cluster, service output (product bundle) is typically tangible, but the process of producing the service is normally customized. A Savile Row tailor offers a customized product and process, which is valued highly by the customer.

For the Type III cluster, service output (product bundle) is typically intangible as valued by customers, and producing the service normally relies on standardized processes and inputs. Typical examples include broadband service, public passenger transport, amusement park and cinema. For this type of service, the outputs are

typically intangible in the form of experience, aesthetics or recreation (Goodman and Steadman, 2002). The same standardized resources are dedicated to different customers, although sometimes with limited levels of variation.

For the Type IV cluster, service output (product bundle) is typically tangible as valued by customers, and the process of producing the service relies heavily on standardized inputs. Typical examples include retailing, automobile dealerships and grocery stores. Generally, these types of services tend to fit at the end of the manufacturing supply chain – handling the distribution of product from manufacturer to customers.

Our verification process (feedback and interview with four field experts and survey of opinions of leading academics) suggests that the proposed typology does not imply absolute homogeneity within clusters, but rather signifies substantial similarity in relation to the chosen dimensions.

5. Forward and reverse service supply chains illustrated

Based on the two-dimensional typology matrix (Figure 2) and the survey responses, we now discuss the conceptual models illustrating the characteristics of the forward and corresponding reverse supply chains for each of the four clusters of services. As our aim is to develop pertinent insight into the main structure of the FSSC and the RSSC, we do not include flow of funds and information in our conceptual models. Instead we focus on the main input and output flows within the SSC. Moreover, we do not extend our conceptual models beyond first-tier suppliers, to give a clear conceptual view of the main value-adding activities of the focal service firm. To assist we have developed a simple schematic for each of our four archetypal FSSCs and RSSCs, highlighting their key features (see Figure 3). A more detailed discussion is provided in the following sections.

[Insert Figure 3 about here]

5.1 Type I forward and reverse service supply chain

In the Type I cluster, the intangible elements are valued highly by customers. The purchasing process entails transfer of the intangible outputs, such as suppliers' capacity, information or knowledge, to customers (Ellram *et al.*, 2004). As the survey respondents pointed out, in exceptional circumstances there may be some minor transfer of tangibles. In the main, though, the physical goods involved play a facilitating role. Moreover, the deployment of tangible inputs by the service firm is relatively small compared to the value added serving a supporting role in the value chain (Porter, 1985). Therefore the conceptual model (Figure 4) does not include tangible outputs as a major flow from the service firm to customers. Instead, intangible inputs, such as data, information, and knowledge, are converted into intangible service outputs (Figure 4). The conversion of customer requirements into service outputs is highly heterogeneous varying from case to case. The provision of Type I services is crucially reliant on the knowledge and expertise of the service firm personnel. The provision of Type I services requires intangible inputs, such as knowledge, information, expertise and experience. In this sense, the forward supply chain of a Type I cluster of services is more of an intangible supply chain.

Furthermore, as indicated by "customer–supplier duality", customers themselves are also suppliers of information or inputs – that is, they are both a recipient of the service and a necessary input enabling the service to be performed (Sampson, 2000). Therefore, in the forward supply chain of a Type I cluster of services, there is simultaneous backward flow of intangible or tangible inputs from the customer to the service firm. Hence the flow of intangible or tangible input in this type of service is bi-directional, and the service firm is the hub of the input flows (see Figure 4).

[Insert Figure 4 about here]

For the Type I cluster, the RSSC processes start, for example, when the customer returns with an uncomfortable condition after medical treatment, with a malfunctioning device after a repair service, or with unsatisfactory solutions from a consultancy firm. Since the service output is normally intangible and produced by non-standardized inputs and resources dedicated to the specific customer, it is very unlikely that the original service output can be returned as with physical goods.

Therefore the start of the RSSC for Type I services invariably triggers a new FSSC (Figure 4). The FSSC and the RSSC are likely to be the same for a Type I cluster of services although the RSSC may be smaller in scale than the original FSSC, because fewer resources or inputs may be required to undertake the rework.

5.2 Type II forward and reverse service supply chain

For the Type II cluster, customer requirements are bespoke and vary from case to case. Customized resources and inputs are deployed according to specific customer requirements. Unlike Type I services, the output bundle for Type II services includes a larger tangible element. According to the survey respondents, although the intangible element of output contributes significantly to the service value added, tangible inputs and outputs are critical for this cluster of services. Type II SSCs more closely mimic manufacturing supply chains, but the service is highly customized and customer driven (Figure 5). Suppliers to Type II services will normally supply tangible inputs to the service firm, such as parts, ingredients, components and materials. The service firm will then deploy its in-house expertise to convert these tangible inputs into tangible and intangible service outputs. For this type of service, customer information, personal data and preferences are important intangible inputs. Therefore the FSSCs of Type II services have a bi-directional element between the focal service firm and its customers (Figure 5).

[Insert Figure 5 about here]

For a Type II service, the RSSC is again likely to be triggered by customer dissatisfaction with the tangible service output. However, since the original service outputs are customized or personalized, it is likely that only a small proportion, if any at all, of the original tangible service output can be returned to the supply chain directly for reuse. Interestingly, a survey respondent commented “an over-cooked dish cannot be recooked or consumed by another customer once served”; “a refurbishment is likely to be modified in situ” (although some removable fixtures can be returned); “a tailored dress/suit is also likely to be modified and if this is not possible, the suppliers of the textiles are unlikely to find any value in taking back the highly modified (i.e. cut) material”. The alternative is using second-hand retailers but this is

unlikely because the service provider would not have the infrastructure and because of potential damage to the brand.

As with Type I services, for Type II services the start of the RSSC process is likely to trigger the start of a new FSSC, since rework is normally needed (Figure 5). However, a low level of recycling or reuse of the original tangible output may be possible for Type II services.

5.3 Type III forward and reverse service supply chain

The Type III cluster possesses the same expected service output characteristics as Type I services, in that the outputs expected by customers are generally intangible. There is essentially very limited or no flow of tangible outputs from the service provider to the customer. These services generally involve the transfer of experience or capability to the customer, or physical transformation (e.g. transport) (Ellram *et al.*, 2004). Even if there is a flow of tangible output between the service firm and the customer, it will account for a very small proportion of the service value offered to the customer. Here, unlike Type I services, the conversion of customer requirements into service output is normally much more standardized and does not vary significantly from customer to customer. To perform the service the firm will deploy standardized tangible or intangible inputs. Therefore, alongside a relatively small degree of intangible input flow generated by limited customer input choices, for Type III services there is significant tangible input flow from suppliers to the service firm (Figure 6).

Moreover, compared to Type I services, although customer information or personal data are an input to the service process, as pointed out by a survey respondent, they are not the key inputs to Type III service processes. The concept of "customer–supplier duality" (Sampson, 2000) is much less prevalent. Therefore we do not consider customer input as an important input flow in the FSSCs of Type III services (Figure 6).

[Insert Figure 6 about here]

For Type III services, the main service outputs are intangible experiences. Such intangible output cannot be returned in the way that physical goods can. A service

output purchased or consumed by the customer in most cases cannot be reversed; it can only be exited/stopped by the customer (and possibly a refund issued). Therefore no reverse flow of output from customers can be identified (Figure 6). However, in some Type III services, such as broadband services, facilitating goods such as internet modems could be returned for reuse; similarly, in others, facilitating goods such as vehicles have recyclable materials, which can be reclaimed.

The equipment, facilities and infrastructure used to provide many examples of Type III services are usually dedicated for specific purposes, and consequently it is normally unlikely for the service firm to be able to return bundles of its fixtures, facilities and equipment back to suppliers. To restore the right level of service, suppliers will normally rework or reinstall the facilities and infrastructures for the service firm, although the scale of rework may be smaller than the original input. Meanwhile, suppliers may renew necessary intangible inputs, such as training and information supply. As such, although both tangible and intangible inputs are needed for the FSSC of the Type III cluster of services, only the tangible part of the inputs may be returned to the supplier in the RSSC for recycle or reuse (Figure 6).

5.4 Type IV forward and reverse service supply chain

For a Type IV cluster, the output valued by the customer is normally highly tangible. The provision of the service to the customer primarily entails distributing standard tangible goods from the supplier to the customer. The service firm is typically located at the end of a manufacturing supply chain with the upstream manufacturer or wholesaler of tangible goods being their main supplier. The direction of flow of the tangible goods is from the supplier to the service firm and then to the customer (i.e. uni-directional). Moreover, the conversion of any customer requirements into output is highly standardized with only small variations from customer to customer. Alongside the tangible goods to be distributed, Type IV services will deploy standardized tangible or intangible inputs and resources, such as point of sales (POS) devices, shelves and employees trained to a standard specification (e.g. sales personnel) to perform the service. Thus there will be tangible and intangible input flows from other suppliers to the service firm, which are separated from the suppliers of goods to be consumed by the customer (Figure 7).

[Insert Figure 7 about here]

The RSSC of a Type IV cluster of services starts with customers returning their tangible service output (i.e. goods). With the exception of rapidly perishable goods (e.g. retail groceries), since the outputs of Type IV services are more tangible and standardized, it is likely that a high proportion of those outputs can be returned back to the supply chain. While the flow of tangible goods is reversed in the RSSC, standardized tangible or intangible inputs and resources are still required by the service firm to carry out its service. Thus there will be continued forward flows of tangible and intangible input from other suppliers to the service firm (Figure 7).

6. Discussion and implications

The heterogeneity of services makes it almost impossible to develop grand theories/concepts. The FSSCs and RSSCs follow this general rule. A better understanding of the characteristics of FSSCs and RSSCs is predicated on the development of an appropriate service typology. We developed such a typology using two dimensions critical in the design and understanding of the FSSC and RSSC – *degree of output tangibility* and *level of standardization of inputs and processes* – underpinned by the extant literature, field experts' comments and interviews, and an extensive survey of leading academics. We then developed FSSCs and RSSCs for each cluster of services, testing their veracity by deploying our three-stage process. The characteristics of the four archetypal FSSCs and RSSCs are summarized in Table 3, showing their unique characteristics and commonalities as well as the configuration of the main input and output flows and their direction in the value-adding process.

We identify how significant the reverse operation is and describe the differences between FSSC and RSSC processes. These differences are governed by the service bundle's level of tangibility.

For Type I services, the role of the RSSC is "perfunctory", since it is limited to recycling facilitating goods or engaging in minor reworking. The RSSC is identical to the FSSC but smaller in scale.

For Type II services, the RSSC plays a "moderate" role, typically concerned with small-scale recycling of tangible output from the customer or return of faulty tangible inputs to the original vendors.

For Type III services, the role of the RSSC is "restricted", since its function is limited to recycling facilitating goods that are substantial in nature.

For Type IV services, the role of the RSSC is "weighty" as there is significant opportunity for recycling of tangible goods – a significant element of the service.

[Insert Table 3 about here]

The following points arise from the delineation of the different characteristics of the FSSC and the RSSC. First, services deploying non-standardized inputs to produce bespoke outputs are generally dependent on customer inputs – data, information, service users – resulting in bi-directionality in the FSSC.

Second, for these services the start of the RSSC will normally trigger a new FSSC chain because the service output generated will vary from customer to customer to meet individual requirements. It is therefore unlikely that the original output would be returned back to the supply chain directly. Hence, the RSSC operates as a forward "rework" chain. There may also be limited opportunity for reusing or recycling some of the facilitating goods.

Third, services deploying non-standardized inputs to produce bespoke outputs require greater operational flexibility and human resource versatility. The operations system and human capital may need adjustment from customer to customer, thus making quality consistency and service-level maintenance more difficult in both the FSSC and the RSSC. Especially when the reverse process is triggered by an unsatisfied customer or service failure, it is more critical for the service firm to reconfigure its resources and human capital to recover its services. According to the service recovery literature (e.g. Hart *et al.*, 1990; Spreng *et al.*, 1995; Webster and Sundaram, 1998; Miller *et al.*, 2000) customer loyalty will be maintained if adequate efforts are made to create rapid response to customers, to empower employees to generate local solutions and possibly to utilize customer criticism as an input to service recovery.

Fourth, the more tangible the output component of the service bundle, the higher the proportion of the service output that could be returned in the RSSC for recycling, reuse or resale (or disposal). Intangible service outputs do not readily lend themselves to be "reversed" or returned once consumed or once the service-delivery process has commenced. Instead, they can only be stopped, or sometimes reworked. Thus it is not feasible to reverse the intangible elements of a service along the supply chain, which is very different from the RSC of manufacturing firms (e.g. Lau and Wang, 2009; Govindan and Popiuc, 2014).

6.1 Practical implications

The FSSC and RSSC typologies presented in this paper offer practising managers a classification system enabling them to better design their FSSCs and RSSCs. The typologies clarify and group together services based on the service bundle and customization of inputs and process, the nature of the relationship with customers and the characteristics of the service delivery system. This in turn helps managers to decide on an appropriate level of focus, time and investment in designing and operating their FSSCs and RSSCs. The supply chain, relationship with suppliers and channels of distribution are among the critical elements of firms' business models. They assume greater importance in service firms because customers and the information they provide are among the important component inputs of, and integral to, channels of distribution. The typologies presented in this paper help managers to better align the internal elements of their business model – an important source of competitive advantage. Furthermore, they help with external alignment and a deeper appreciation of the supply chain contributes to business model innovation.

Another key practical point concerns the increased risk of service inconsistency inherent in the high reliance on customized/non-standardized inputs (Ungan, 2006). To mitigate this risk an effective documentation and talent-retention system is required (Ungan, 2006). This in turn will reduce the need for rework and hence result in cost reduction and shorter recycle lead-time increasing the efficiency of the RSSC. Although input standardization can reduce supply chain risks and improve consistency in the FSSCs and RSSCs, in reality process standardization and output variation can be a trade-off. Managers need to balance the degree of input standardization and output variation to ensure acceptable service levels are maintained

while the cost and extra complexity caused by RSSC processes are minimized. For Type I and II services issues with output are likely to lead to increased costs with no cost recovery opportunity, hence the best way of reducing the costs of the RSSC is not allowing it to happen (Miller *et al.*, 2000).

6.2 Research implications

For academics, the conceptual models of FSSCs and RSSCs and the subsequent typology offer the basis for identifying research gaps and a better ordered exploration of RSSCs. Our proposed typology along with the review of the extant literature suggests an imbalance in the research effort. Most of the previous research has focused on Type IV RSSCs (e.g. Bienstock *et al.*, 2011; Ruiz-Benitez and Muriel, 2014), while the consideration of Type I, II and III services is very sparse. More importantly, the typology allows theoretical developments for each cluster of services and their FSSCs and RSSCs and better focused empirical research.

It was not our intention to provide a fine-grained specification of the actual value chain process through which service outputs are produced. For example, we do not include the flow of information in our conceptual models, unless the flow of information forms an important service input, as in the case of Type I and II services. This is because the service sector is highly heterogeneous and our intention was to provide, as clearly as possible, a differentiation between the four service clusters and their resultant FSSCs and RSSCs focusing on primary value-adding activities. In doing so, we highlight the distinct characteristics of the FSSC and RSSC of each cluster of firms. Future researchers, however, could extend our conceptual models by adding flows of funds, information and knowledge – developing a fine-grained representation of supply chains of firms in each cluster.

It is also important to note that some services and their associated FSSC and RSSC may fall on or close to the boundaries delineating the four clusters, a common issue with all typologies. This point was alluded to by a number of experts participating in our survey. For example, a cruise ship offers a bundle of both intangible and tangible outputs, based on both standardized and customized service outputs (Veronneau and Roy, 2009), thus having characteristics of different RSSCs. This raises an important point concerning the level of analysis for future researchers using our typology and

conceptual models. Many service firms provide a combination of different types of services. For example, a cinema nowadays is likely to offer movie screening (Type III), restaurant facilities (Type II) and retail merchandising (Type IV) at the same time. A medical tourism service combines medical service (Type I) and tourism (Type III) (Lee and Fernando, 2015). Therefore for future researchers the choice of unit of analysis assumes greater importance, for example, the firm or its business units. It may be more pertinent to focus on the FSSC and RSSC of the business unit to develop a finer grained understanding. Our typology helps researchers to better choose their unit of analysis.

7. Conclusions

Prior research has tended to apply manufacturing-oriented frameworks directly or with limited modifications to examining SSC management (Swank, 2003; Ellram *et al.*, 2004; Giannakis, 2011), hence limiting the opportunity for developing generalizable service-specific theories. Here we present the basic structure of FSSCs and their corresponding RSSCs related to four general service clusters. The conceptual models presented will help future researchers and practitioners to better clarify the processes of the FSSC and RSSC of each cluster of service firms, and to develop better solutions to reduce service gaps, optimize service value chains and enhance the potential for value recapture or creation from RSSC activities. We explore both the FSSC and RSSC for each of our clusters because we firmly establish that the FSSC and RSSC are not mutually exclusive. This is particularly important given the limited previous research addressing service firms' supply chains.

This paper, while making a unique contribution, has a number of limitations leading us to propose areas for future research. First, our conceptual models serve as a starting point and may not neatly fit all the different types of service provision. In reality there may be many services that fall at the intercept of our typology matrix, or there will be some exceptions not fitting into our typology matrix. However, our typology is more of what Kellog and Nie (1995) referred to as a "midrange" typology of services, which restricts the scope to more manageable segments, rather than a "grand" typology capable of embracing all organizations. Therefore most service firms will fit into the matrix or find useful insights from using the service typology and the related FSSC and RSSC typologies. However, alternative typologies may be needed to cater

for some services, and there may be other ways of categorizing SSCs to augment our conceptualization of the RSSC. Future researchers may wish to explore other dimensions of service classification to develop finer grained classification schemes.

Second, as was pointed out by the experts responding to our survey, we do not claim that the four parsimonious conceptual models are an absolute representation of all services. Our models can be criticized as being oversimplified, particularly given the breath covered by service firms. However, our conceptual models will allow for easier evaluation and comparison of different service firms' FSSCs and RSSCs. Our conceptual models provide a starting point for examining the variation and commonalities in FSSCs and RSSCs and they pave the way for a more focused conceptualization of SSCs.

Third, the conceptualization of forward and reverse supply chains in this paper does not extend to the network structure of many supply chains, or incorporate the dimension of supply chain collaborations (Chakraborty *et al.*, 2014; Lee and Fernando, 2015). In our conceptual models we did not extend the supply chain beyond first-tier suppliers or customers. This is because we sought to bring a high level of initial clarity to the conceptual models. Future research could elaborate more on the extended network structure of the SSCs and on collaborative relationships between SSC actors.

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Table 1. Selected previous service typologies

Selected reference	Classification dimensions	Comments
Judd (1964)	(1) Rented goods services (2) Owned goods services (3) Non-goods services	The typology recognizes that customers can be suppliers of service inputs in the supply chain process. However, "non-goods services" is too broad as a classification dimension, which can be extended into many sub-categories.
Rathmell (1974)	(1) Type of seller (2) Type of buyer (3) Buying motives (4) Buying practice (5) Degree of regulation	Equally applicable to the manufacturing sector. The typology does not help to explain service supply chain processes.
Hill (1977)	(1) Private services (2) Collective services (3) Externalities	A classification from an economics perspective, which does not provide direct implication to the service supply chain.
Shostack (1977)	(1)Tangible dominant (2) Intangible dominant	Recognizes the possibility of bundles of intangibles and tangibles in services have a direct implication on the flow of service input and output in supply chains.
Kotler (1980)	(1) People-based vs. equipment-based (2) Extent to which client's presence is necessary (3) Meets personal needs vs. business needs (4) Public vs. private, for-profit vs. non-profit	A synthesis of different previous classification criteria. Does not have direct implications to on the service supply chain.
Chase (1981)	(1) High customer contact (2) Low customer contact	Too broad in classification for understanding the service supply chain, further sub-categories are needed.
Lovelock (1983)	(1) Nature of the service act (2) Relationships with customers (3) Customization and judgment in service delivery (4) Nature of demand for the service relative to supply (5) Method of service delivery	The first criterion recognizes the nature of the service act being either tangible actions or intangible actions. The third criterion recognizes the level of customization in services. The fifth criterion recognizes the type of customer interaction with the firm and whether the service is delivered on a single or multiple sites.
Schmenner (1986)	(1) Degree of interaction and customization (2) Degree of labour intensity	The second dimension is less clear for modern services firms. Thus the classification cannot be used directly to explain the service supply chain.
Mersha (1990)	(1) Active customer contact (2) Passive customer contact	An extension of the customer contact model (CCM) of high, low or mixed customer contact. But it does not give direct implications to the concept of the service supply chain.
Chase and Hays (1991)	Four-stage scheme (1) Available for service (2) Journey man (3) Distinctive competence achieved (4) World class service delivery	Four-stage scheme distinguishes among service firms according to their general effectiveness in service delivery at different stages of development. Cannot be used directly to understand service supply chain.
Kellog and Nie (1995)	(1) Service process structure in terms of customer influence: Expert service, Service shop, Service factory (2) Service package structure in	The two dimensions service process / service package matrix has a customer-focused approach, but cannot be directly used to understand the service supply chain process.

	terms of degree of customization: Unique, Selective, Restricted	
Goodman and Steadman (2002)	(1) Physical (2) Intellectual (3) Aesthetic (4) Service of experiential value	A generic typology recognizes services being diversified in providing physical goods and intangible services. Helps to explain different types of service output generated by service firms along the supply chain.
Davis and Heineke (2003)	Proportion of goods and services making up a service product	Recognizes the possibility that services can be bundles of goods and services. Helps to explain different types of service output generated by service firms along the supply chain.

Table 2. Profile of experts responding to the semi-structured survey

Area of expertise	**Frequency**	**Percentage**
Supply chain management	7	33.3
Operations management	7	33.3
Purchasing and procurement management	4	19.0
Marketing	1	4.8
International logistics	1	4.8
Business forecasting	1	4.8
Years of experience		
1 to 5	4	19.0
6 to 10	4	19.0
11 or more	13	61.9
Country		
UK	15	71.4
China	3	14.3
United States	1	4.8
Spain	1	4.8
Denmark	1	4.8
Total	21	100

Table 3. Characteristics of forward and reverse service supply chains

Service type	Output tangibility	Process and input standardization	Typical example	Formation of forward supply chain	Formation of reverse supply chain	Role of Reverse Supply Chain
Type I	Mainly intangible	Mostly customized	Business consultancy, Medical service, Repair service	Forward flow of intangible and tangible input from suppliers to service firm. Tangible input limited to facilitating goods. Backward flow of tangible and intangible input from customer. Forward flow of intangible output from service firm to customer.	Rework supply chain, identical to forward supply chain but smaller scale.	**Perfunctory**: reverse supply chain limited to recycling facilitating goods.
Type II	Mainly tangible	Mostly customized	Fashion design services, Tailor shop, House refurbishment, Gourmet restaurant	Forward flow of tangible input to from suppliers to service firm. Backward flow of intangible input from customer. Forward flow of tangible and intangible output from service firm to customer.	Rework supply chain similar to forward supply chain but smaller scale. Partial recycling or reuse of tangible output from customer or return of faulty tangible input to suppliers.	**Moderate:** reverse supply chain offers moderate opportunity for recycling.
Type III	Mainly intangible	Mostly standardized	Cinema, Broadband internet, Passenger transport	Forward flow of tangible and intangible input to service firm. Forward flow of intangible output to customer. Limited or no forward flow of tangible output to customer.	Rework supply chain to service firm only when service faults accumulate. Limited or no recycling or reuse of tangible output from customer. Partial recycling or reuse of tangible input by suppliers of facilitating goods.	**Restricted:** reverse supply chain restricted in its recycling potential to elements involved in delivery of service.
Type IV	Mainly tangible	Mostly standardized	Retail groceries, Fast food restaurant, Car dealer,	Forward flow of tangible goods from suppliers to service firm.	Backward flow of returned or recycled tangible goods. Continued	**Weighty:** reverse supply chain offers significant opportunity for recycling of

			Clothing retail	Forward flow of tangible and intangible input from suppliers of facilitating goods and services to service firm. Forward flow of tangible output from service firm to customer.	forward flow of tangible and intangible inputs from suppliers of facilitating goods and services to service firm.	goods.

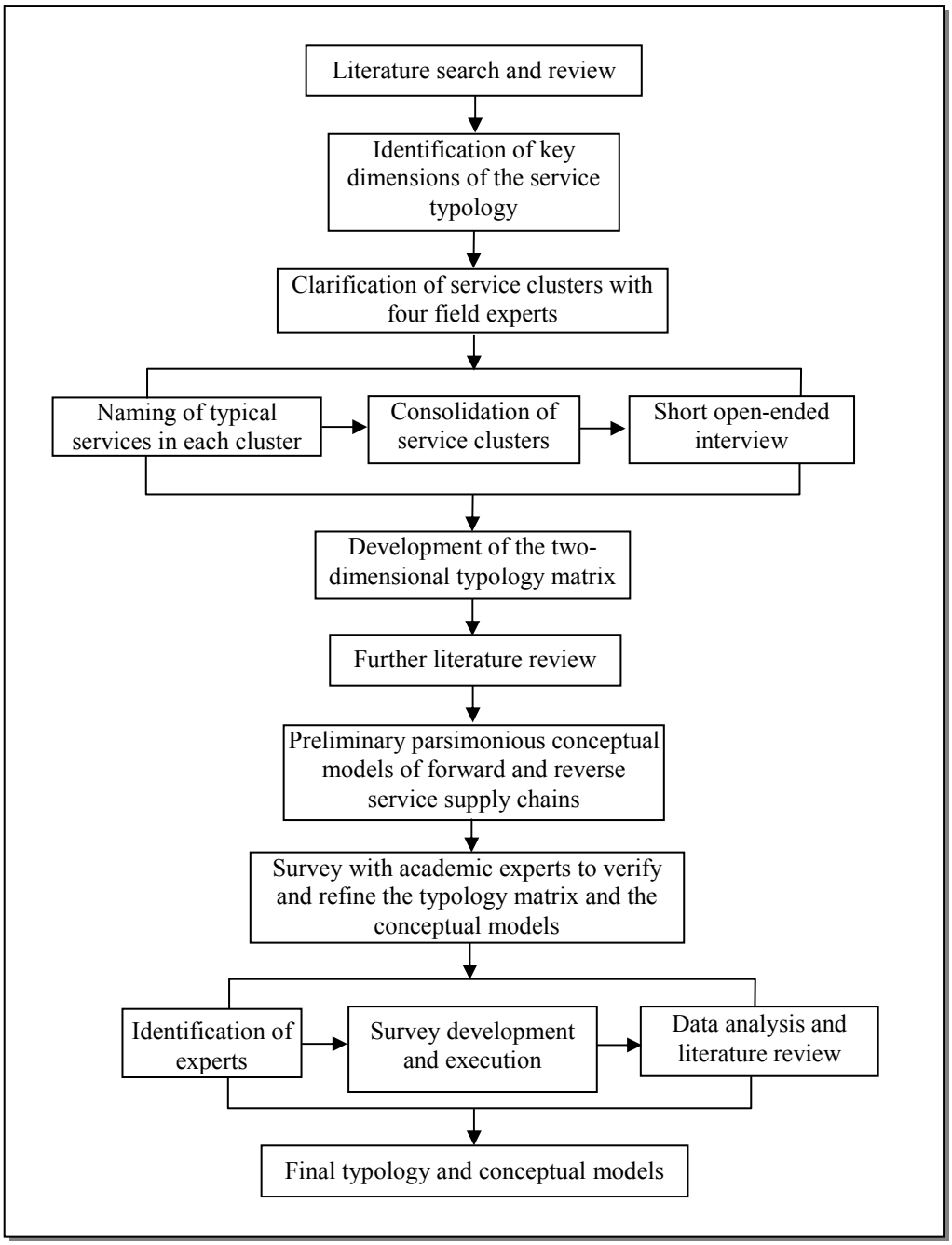

Figure 1. Conceptual model development process

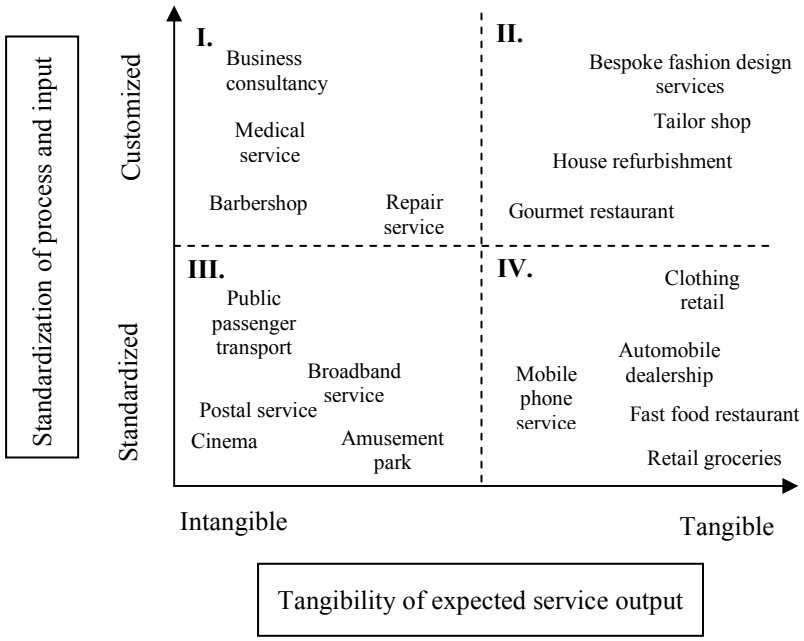

Figure 2. Process standardization: output tangibility matrix

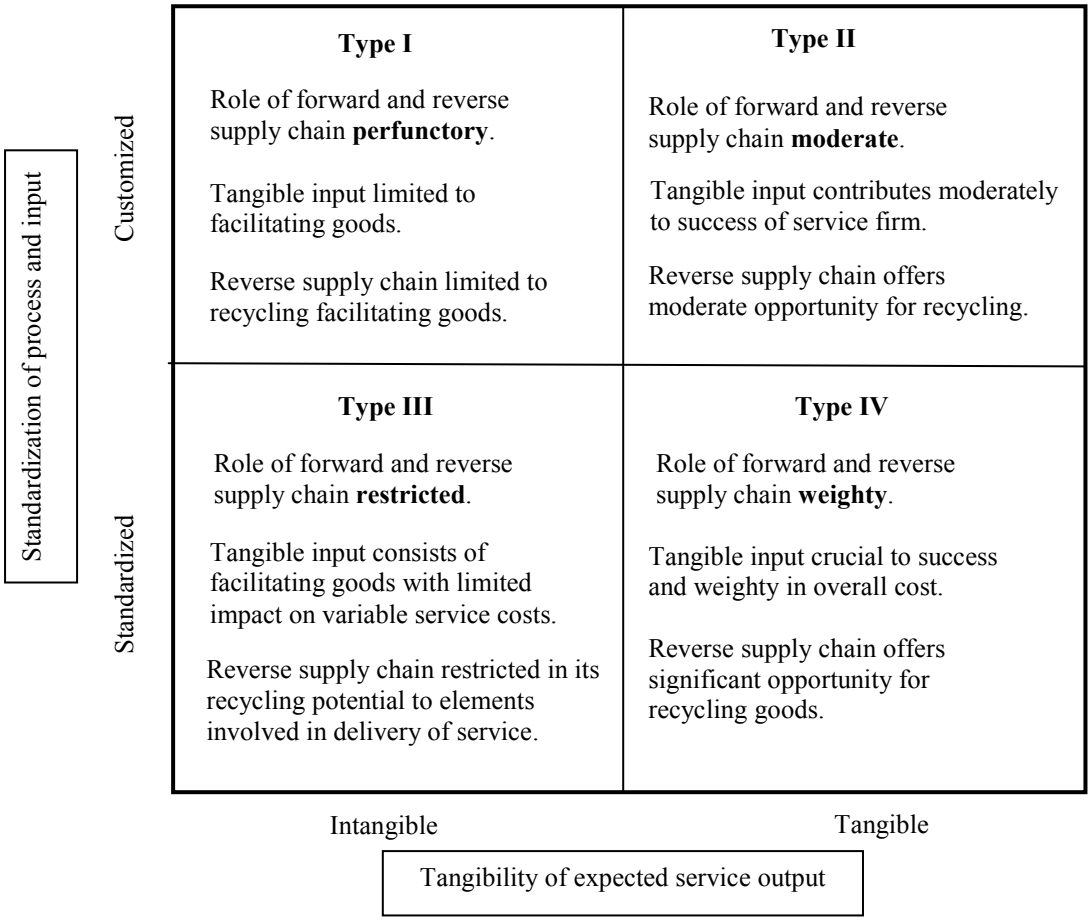

Figure 3. Forward and reverse service supply chain typology

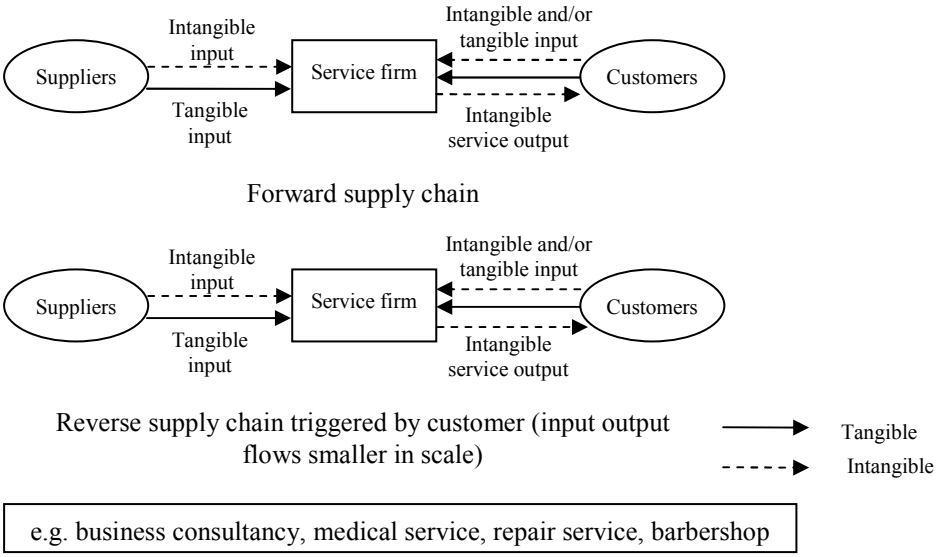

Figure 4. Type I forward and reverse service supply chains

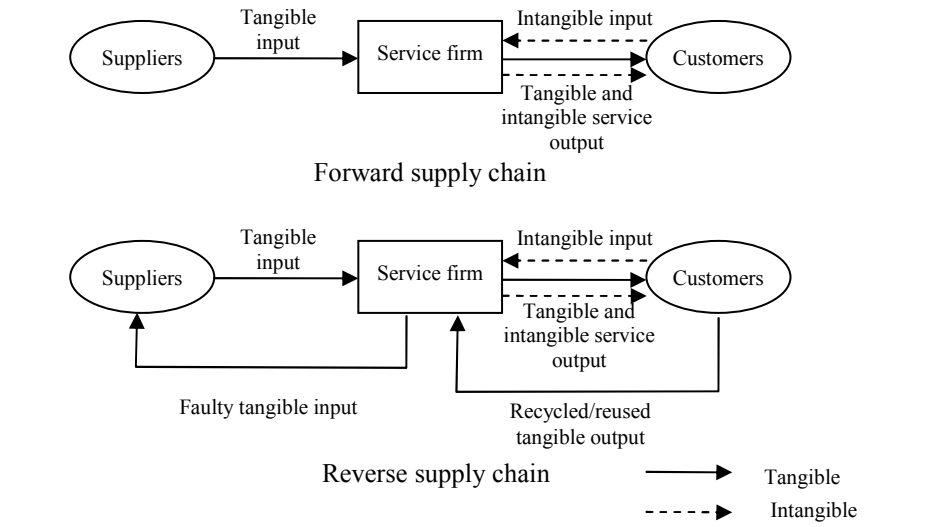

Figure 5. Type II forward and reverse service supply chains

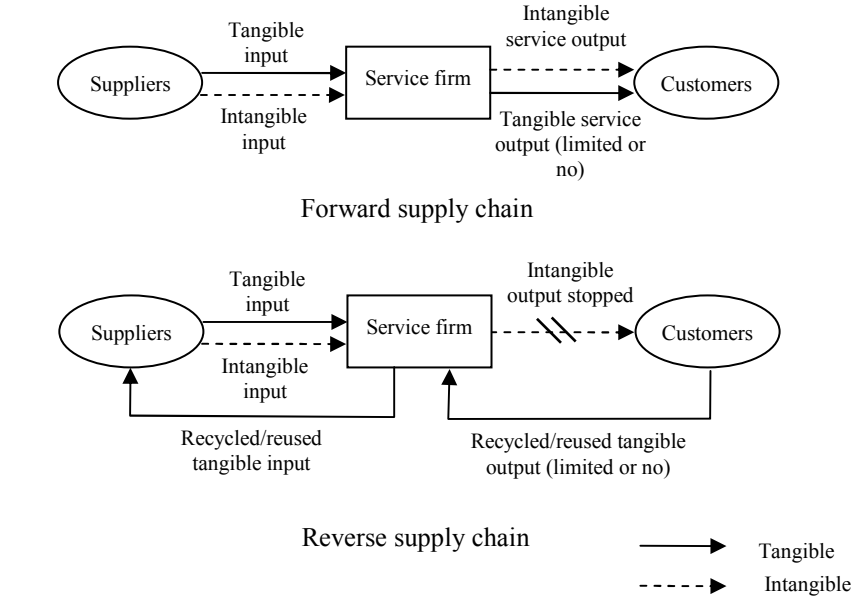

Figure 6. Type III forward and reverse service supply chains

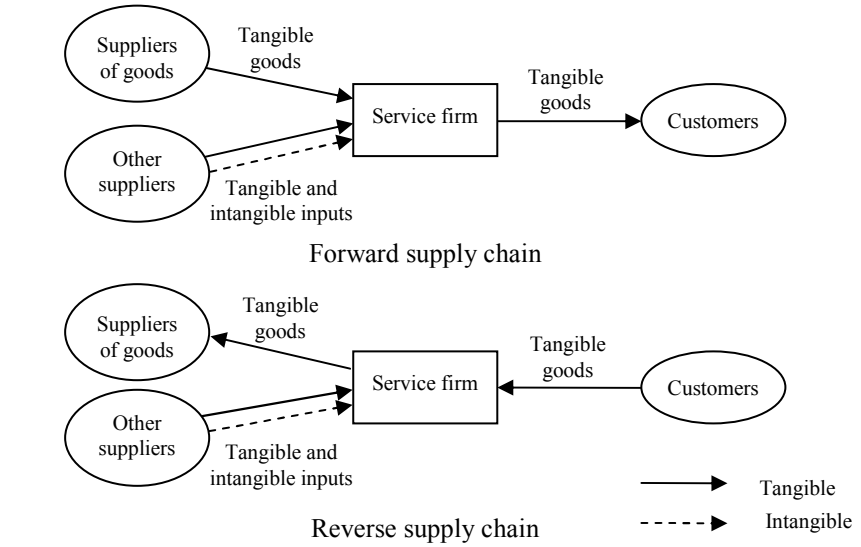

Figure 7. Type IV forward and reverse service supply chain